FARMING PRACTICE INTERCROPPING

IMPACT: CROP YIELD

Reference 19

Yu, Y; Stomph, TJ; Makowski, D; van der Werf, W 2015 Temporal niche differentiation increases the land equivalent ratio of annual intercrops: A meta-analysis Field Crops Res. 184, 133–144 10.1016/j.fcr.2015.09.010

Background and objective

Intercropping is a strategy for increasing agricultural productivity per unit land that is based on ecological mechanisms for improved resource capture. No quantitative synthesishas been made on the effect of intercrop system properties and species trait combinations on intercrop productivity. Authors conducted a meta-analysis of the intercropping literature to study how the productivity of mixed systems is affected by intercrop system design and species traits.

Search strategy and selection criteria

A literature search was conducted on the Web of Science CoreCollection (WoSCC) on 21 May 2013. We used as search terms:intercrop* OR "mixed crop*" OR "crop mixture*" OR "mixed cul-tivation*" OR polyculture in the title. The search yielded 3313 publications. Two samples from these 3313 publications were analysed further: a top cited sample and a random sample (Appendix:Table A1 and Table A2). The top cited sample was made by first ranking the 3313 publications according to the citations received between 2003 and 2012 and then screening them one by one until 50 publications had been accumulated that met the inclusion cri-teria (Methods A1 and Fig. A1). A second sample of 50 publicationswas made by simple random sampling from the entire database,excluding the 50 publications already included in the top-citedsample (Methods A1 and Fig. A1). Inclusion criteria of publications for the top cited sample are: (1) peer reviewed English language publication, i.e. excluding conference proceedings, (2) reporting primary data, i.e. excluding reviews (3) reporting field data on annual intercrops, thus excluding publications on systems with perennials, (4) reporting yield data on both intercrops and sole crops, (5) reporting treatments in which pests, diseases and weeds had been adequately controlled, (6) intercropping design was either replacement or additive, (7) reporting of sowing and harvesting dates or reporting total duration and overlapping period of intercrops to allow estimating temporal niche differentiation, (8) reporting consistent results, i.e. excluding publications with discrepancies between reported LER and yield data, or inconsistencies between data in different figures and tables. In the case of the top cited sample authors selected only those publications that reported information on all key explanatory variables. The criterion of completeness of data was not applied to the random sample because only few randomly sampled publications reported information on all explanatory variables.

Data and analysis

All analyses were conducted in R. Mixed effects models were fitted using the R function lme from the R package nlme. The assumption of equal variance for mixed effects models was checked by analyses of quantile plots and plots of residuals against fitted values. A negative correlation structure of data between the cereal and the legume from the same data record was added in the mixed effects models using the R function corCompSymm for the argument of correlation in lme. A non-linear model of the relationship between PLER of the cereals and PLER ofthe legumes was fitted to the data using the R function gnls. A comparison of good-ness of fit between the linear mixed effects model (model 1) andthe non-linear model (model 10) was conducted with Akaike infor-mation criterion. In this meta-analysis, authors did not use the inverse variance of LER as a weight since there were toofew publications reporting measures of variance of yields.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
100	Multiple crops	Intercropping	Monoculture	Metric: Land equivalent ratio (LER); Effect size: Sum of the fractions of the intercropped yields divided by the sole-crop yields	87.5

Results

- Intercrops increased LER compared to sole crops (the median LER in the whole data set was 1.17, and the mean1.22 ± 0.02).

Factors influencing effect sizes

- Geographical area : LER was significantly higher in Asia than in Europe, Africa or Latin America. No significant difference of LER between any two other continents was observed.
- Crop/cultivar combinations : LER of C_3/C_4 intercrops was significantly higher than of C_3/C_3intercrops. Temporal niche differentiation contributed substantially to high LER in systems combining a C_3 and C_4species, but not in systems based on C_3 species mixtures.
- Crop spatial arrangement : LER of mixed intercrops was lower than of row and strip intercrops while the difference was only significant between mixed and strip intercrops.
- Crop density : LER increases if densities are increased beyond component replacement.
- Fertiliser application : There was a significant positive interaction between temporal niche differentiation (TND) and the amount of N applied to the intercrop, indicating that niche complementarity between a short and a long season crop with relatively short period of overlap is more fully expressed when high levels of nutri-ents are provided.

Conclusion

Substantial improvements in land use efficiency in agriculture may be obtained by using mixtures, par-ticularly C_3/C_4 mixtures. Thus, enhanced within-field crop diversity can make an important contributionto sustainable increases in food production.